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STRUCTURE OF WOOD, (U)
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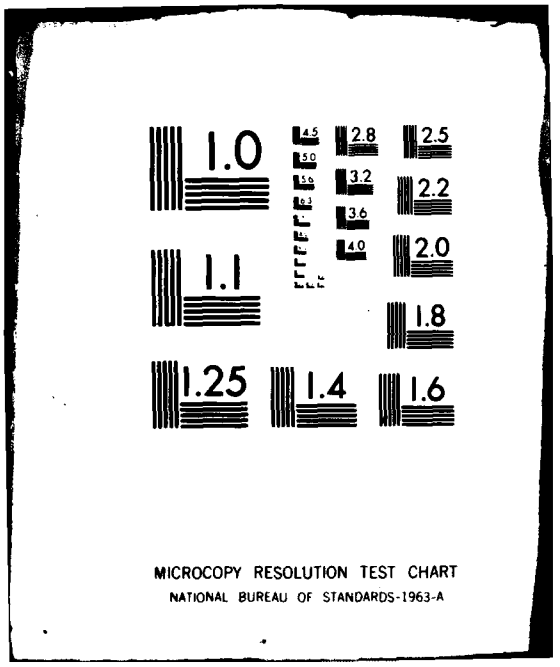
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MICROCOPY RESOLUTION TEST CHART
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United States Department of Agriculture

Forest Service

Forest Products Laboratory

Research Note FPL-04

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Structure of Wood

LEVEL II

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Structure of Wood

Wood, instead of being a relatively solid material like steel or concrete, is basically composed of many tubular fiber units, or cells, cemented together. Many properties of wood are related directly to its structure. The following descriptions explain the distinguishing cellular characteristics of a hardwood and a softwood.

Structure of a Hardwood

Figure 1 is a drawing of a cell structure of yellow-poplar as an example of a minute block of hardwood. The drawing shown here represents a block about 1/32 inch high. The horizontal plane **TT** of the block corresponds to a minute portion of the top surface of a stump or end surface of a log. The vertical plane **RR** to the left corresponds to a surface cut parallel to the radius; and the vertical plane **TG** to the right corresponds to a surface cut at right angles to the radius, or tangentially within the log. In hardwoods, these three major planes along which wood may be cut are known in common practice, respectively, as end grain (TT), quarter-sawed (RR), and plain-sawed (TG) surfaces.

The hardwoods have specialized structures called vessels for conducting sap vertically, which on the end grain appear as holes or pores, **P**. Therefore, hardwoods are referred to as porous woods in contrast to nonporous softwoods in which the sap is transferred vertically only through cells called tracheids.

The vessels are made up of relatively large cells with open ends set one above the other and continuing as open passages or tubes for relatively long distances.

The pores of hardwoods vary considerably in size, being visible without a magnifying glass in some species but not in others. In most hardwoods the ends of the individual cells of the vessels are entirely open, whereas in others, the opening has crossbars as indicated by **SC** on the radial surface.

Most of the smaller cells seen in the cross section of the drawing are wood fibers, **F**, which are the strength-giving elements of hardwoods. They are spindle-shaped cells usually having small cavities and relatively thick walls. Thin places or pits, **K**, in the walls of the wood fibers and vessels afford means for the passage of sap from one cavity to another. The wood rays **WR** are strips of short horizontal cells that extend in a radial direction and serve to store food and distribute it horizontally. In the drawing, most of the rays shown in the surface **TG** are pictured as being two cells wide, but the width varies in different species of hardwoods from 1 cell, as in the willows and cottonwoods, to over 50 cells in the oaks.

In woods of the temperate climate, the growth of one year **AR**, commonly known as the annual ring or growth ring, is usually sharply defined from that of the previous or following year. As a rule, the wood formed in the spring, called springwood or earlywood, **S**, is more porous than that formed later in the year, called summerwood or latewood, **SM**.

All the cells in the wood are firmly cemented together by a thin layer, the middle lamella. This thin, intercellular layer can be dissolved by certain chemicals, thus permitting the fibers to be separated, as is done in making paper from wood.

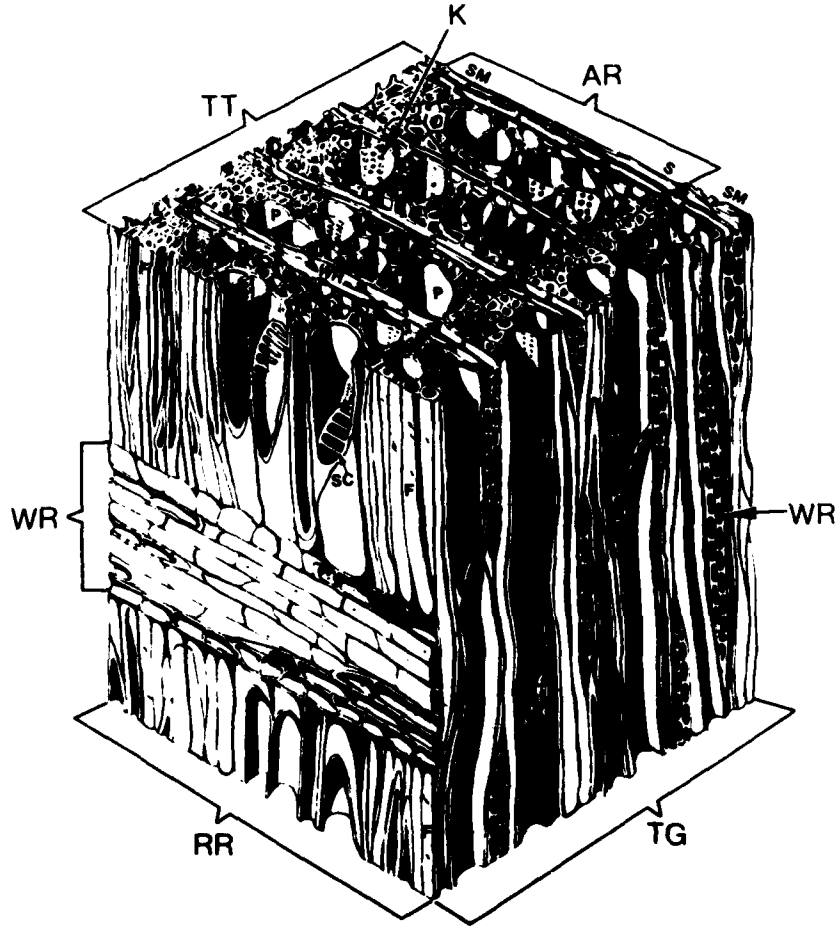

Fig.1 Cell structure of a hardwood

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Structure of a Softwood

Figure 2 is a drawing of the cell structure of a minute block of softwood, white pine. The drawing here shows a cube about 1/32 inch on a side.

The top of the block, **TT**, represents the transverse section or a plane parallel to the top surface of a stump or the end surface of a log. The rectangular units that make up this surface are sections through vertical cells, mostly tracheids **TR**. Tracheids are elements that serve the dual function of transporting the sap and giving strength to the wood. The walls of tracheids form the bulk of the wood substance in softwoods. Between the various cell units is the cementing layer, or middle lamella. This thin, intercellular layer can be dissolved by certain chemicals, thus permitting the cells to be separated in making paper. Springwood or earlywood cells, **S**, which are formed during the early part of the year's growth are distinguishable by their greater size from the summerwood or latewood cells, **SM**, which are formed during the later part of the growing period. Together, the earlywood and the latewood cells make up the growth ring or annual ring, **AR**. One such ring is added each year on the outside of the wood previously formed and immediately under the bark.

Wood rays, **WR**, are strips of short horizontal cells that extend in a radial direction across the growth rings. The function of the wood rays is to store and to distribute horizontally the food material of the tree. They are mostly one cell wide but, in softwoods that normally have resin ducts, fusiform wood rays, **FWR**, are present which have a horizontal resin duct, **HRD**, at their center and are several cells wide. The large hole in the center of the top surface is a vertical resin duct, **VRD**.

The left side surface **RR** represents a vertical plane along the radius of the trunk. This surface is commonly called edge grain in softwood lumber and corresponds to the quarter-sawed surface in hardwoods.

The surface **TG**, at right angles to the radial or edge-grain surface, corresponds to the flat-grain or plain-sawed surface of lumber.

The symbol **SP** indicates a simple pit, an unthickened portion of the cell wall through which sap passes from ray cells to tracheids or vice versa. The bordered pits **BP**, seen in section on surface **TG**, have their margins overhung by the surrounding cell walls; these structures allow the flow of sap from one tracheid to another.

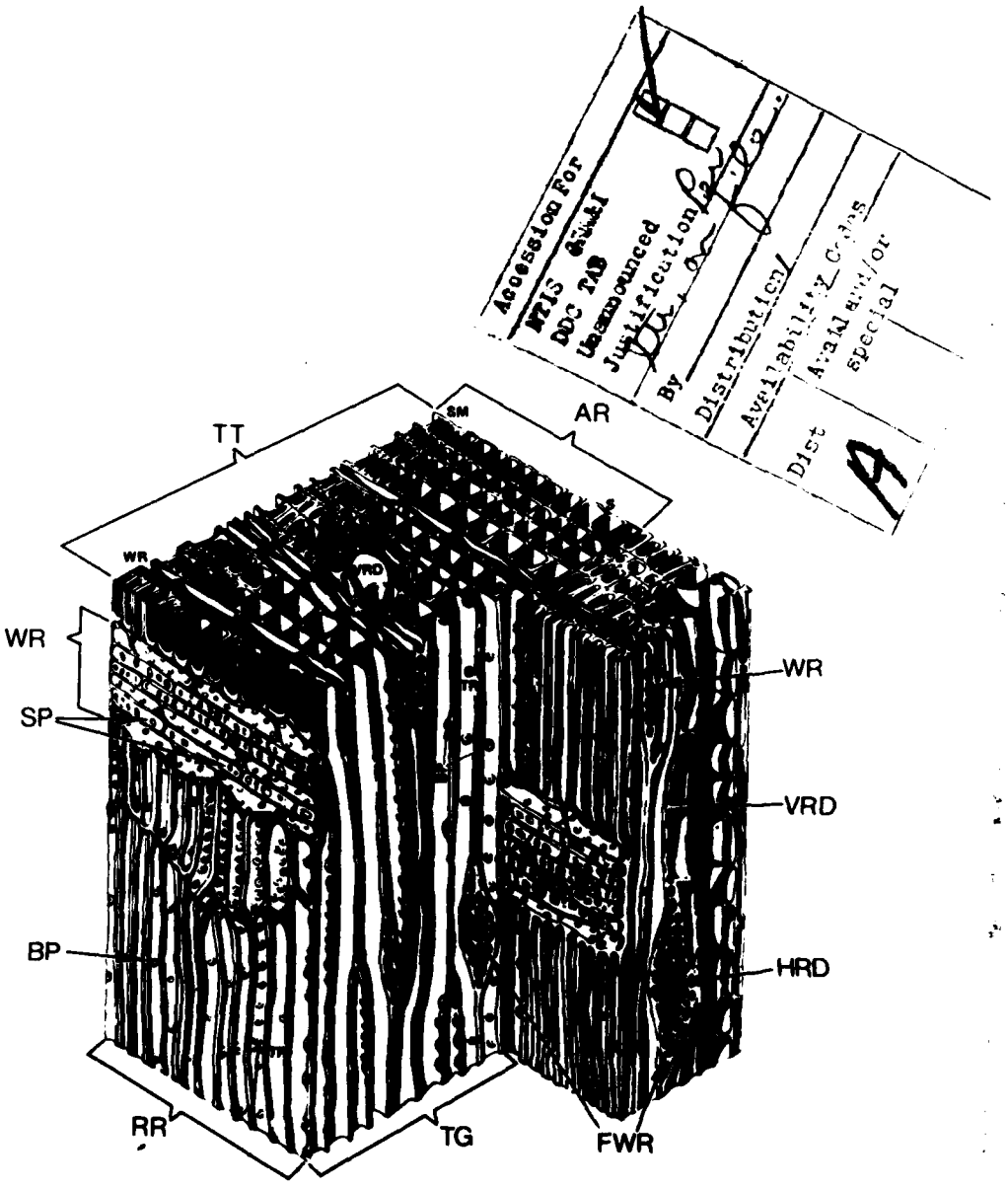

Fig. 2 Cell structure of a softwood

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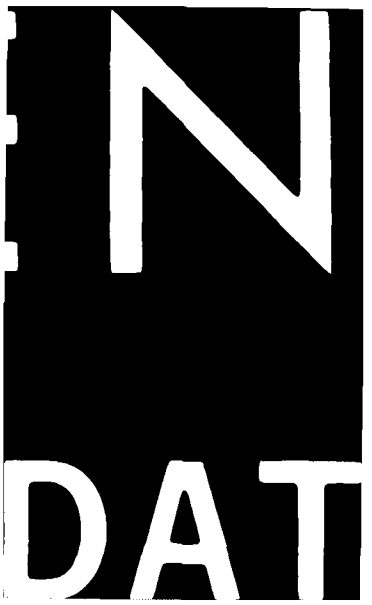
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